A TOF Detector for PID at the EIC

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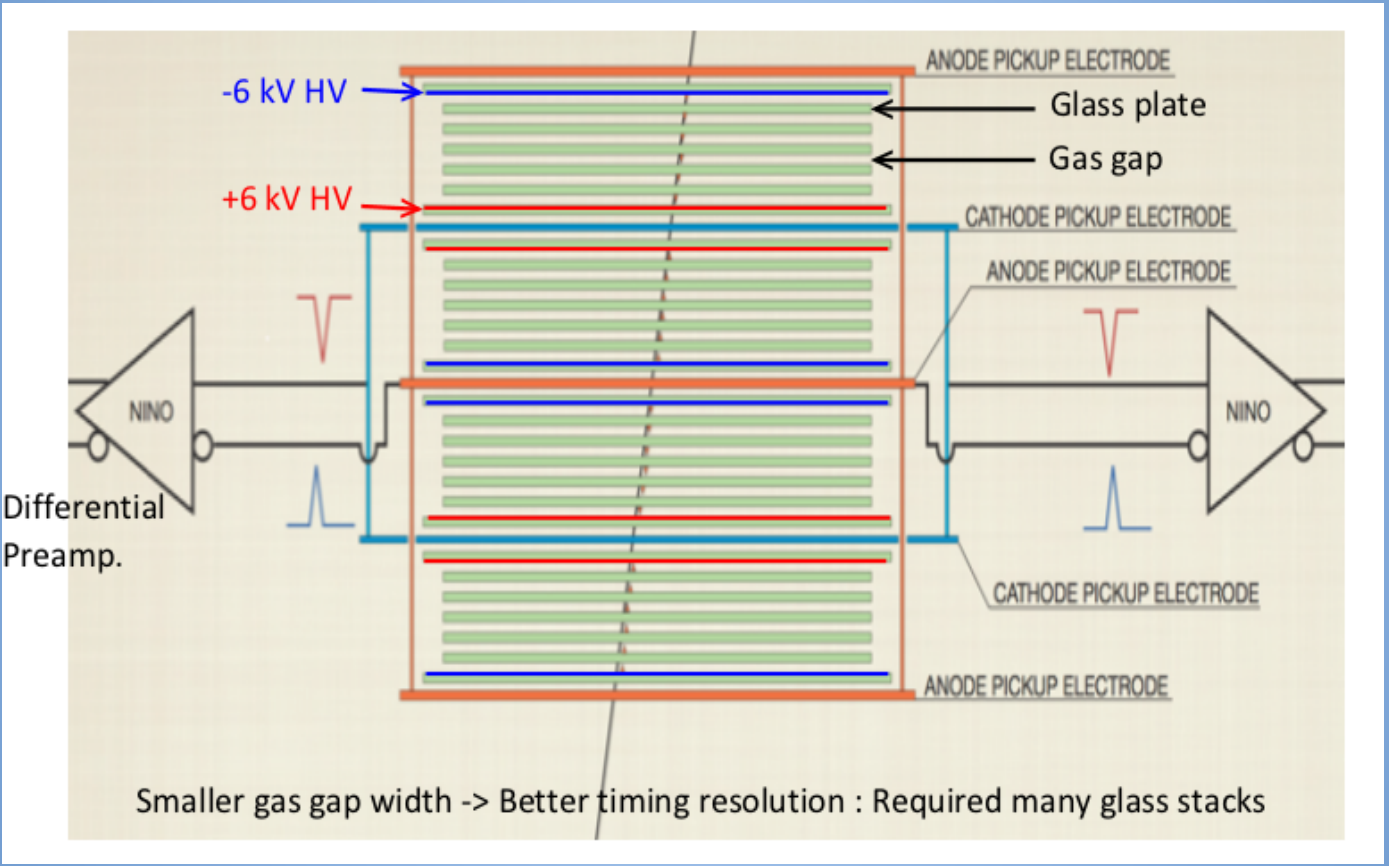
Chong Han
University of Illinois at Urbana-Champaign

TOF DETECTOR IDEA

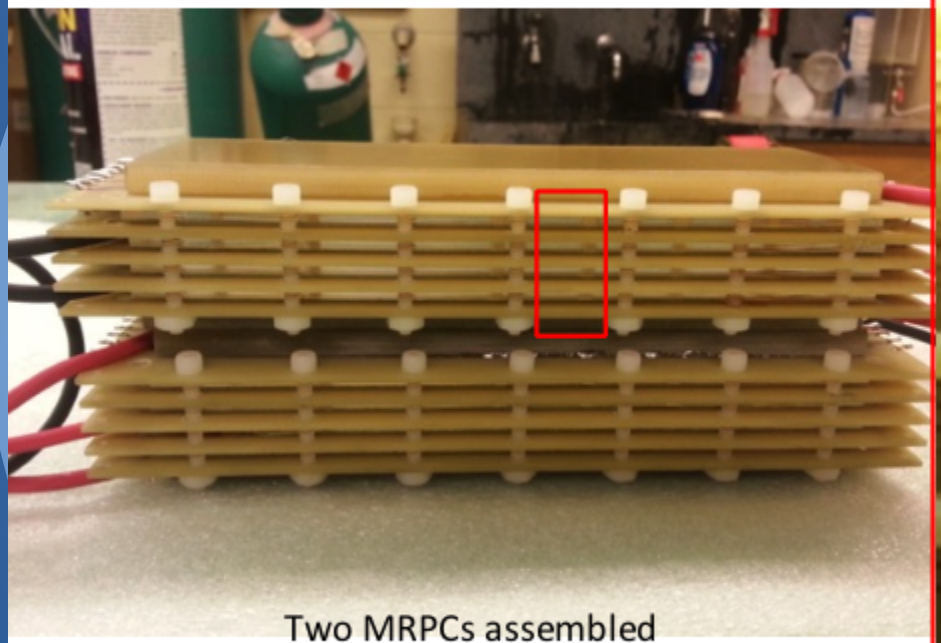
- A possible TOF design with 10ps resolution using mRPC/MCP
- PID for pion and kaon at low momentum
- PHYSICS: Extract quark transversity through SIDIS with identified hadrons (pion/kaon fragmentation function available from Belle)

HARDWARE

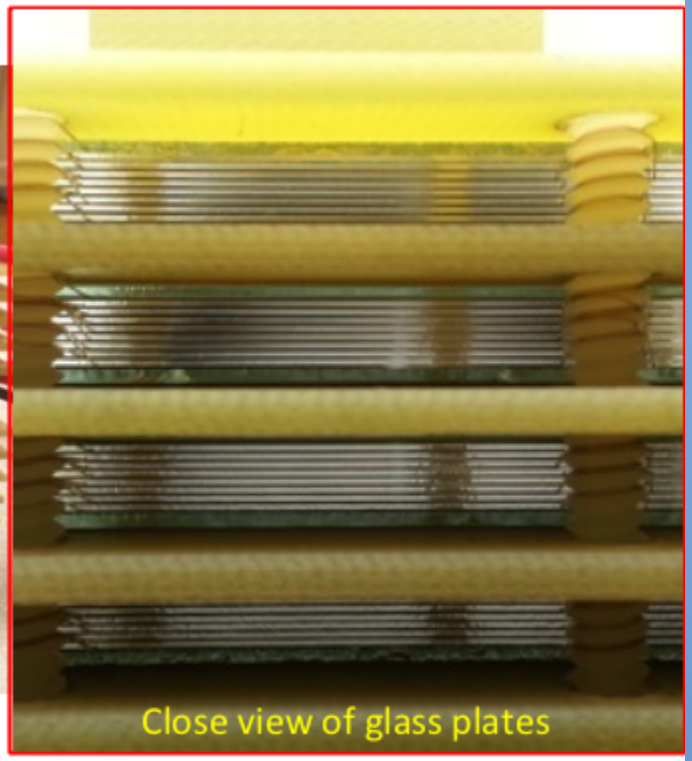


Schematic of mRPC design (from IhnJea Choi, more slides available in Micky's presentation in EIC PID Meeting 03/23/2015)

HARDWARE

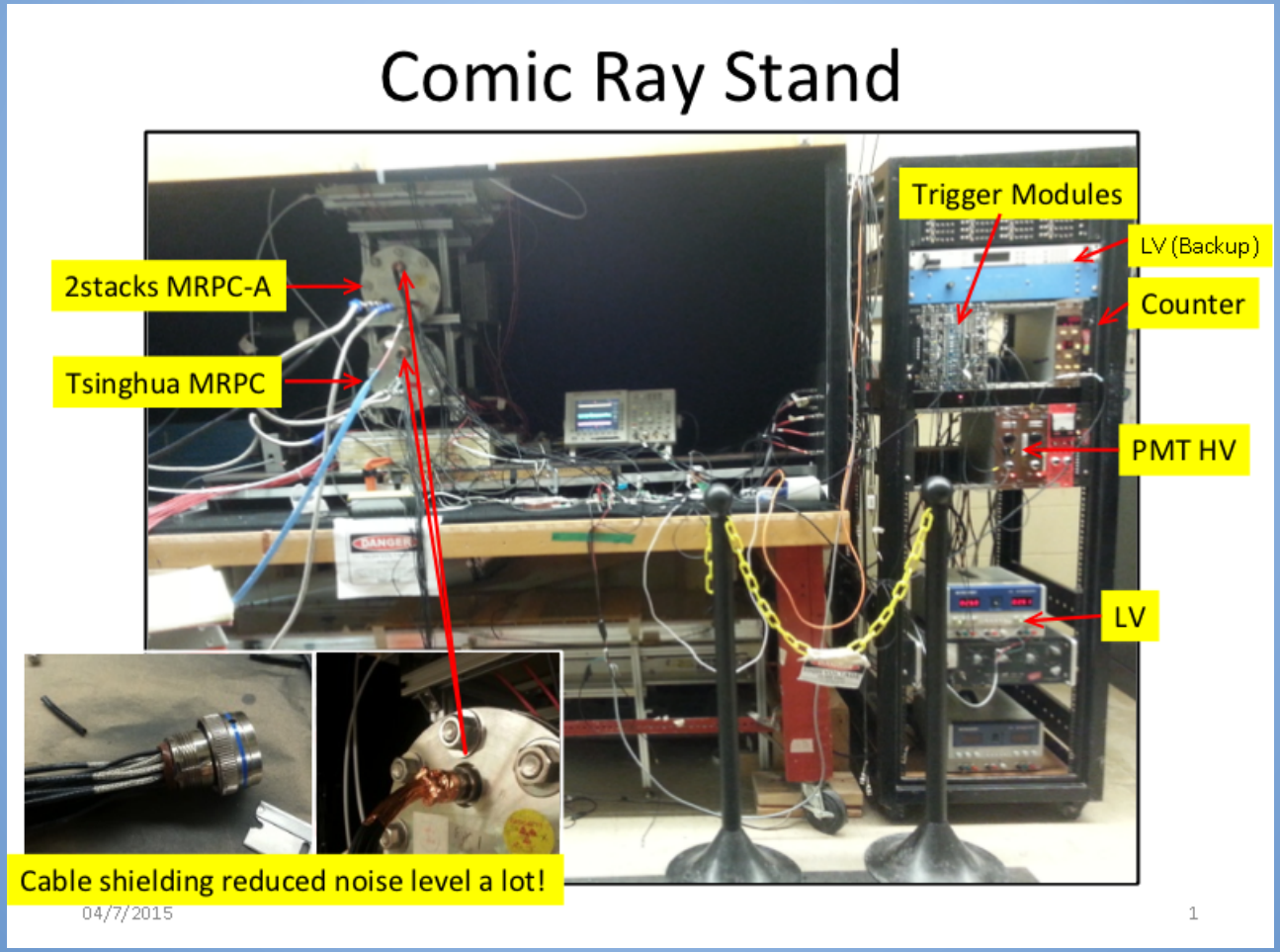


Two MRPCs assembled



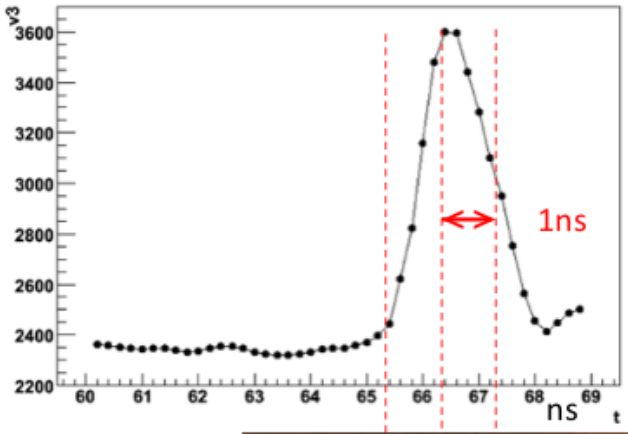
Close view of glass plates

HARDWARE

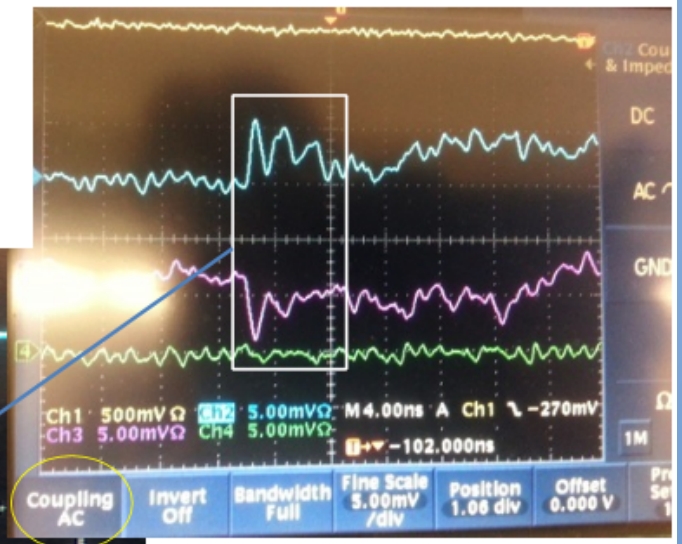

Comic Ray Stand
Trigger Modules
LV (Backup)
Counter
2stacks MRPC-A
Tsinghua MRPC
PMT HV
LV
Cable shielding reduced noise level a lot!
04/7/2015
1

HARDWARE

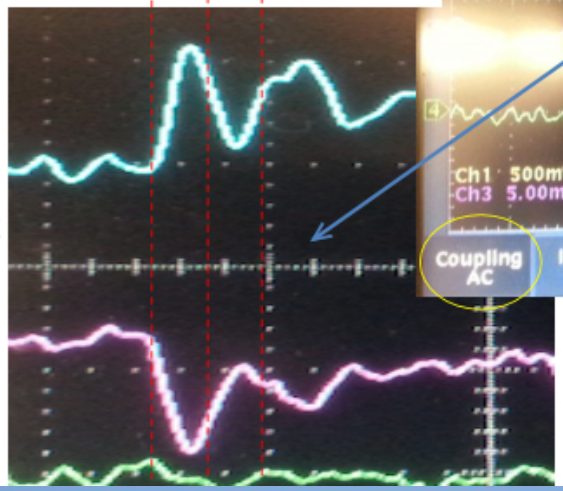
Signal from 1st Prototype MRPC (2014) with preamp



Signal Comparison



Raw signal from 2nd Prototype MRPC (2015)



4ns/div, 5mV/div

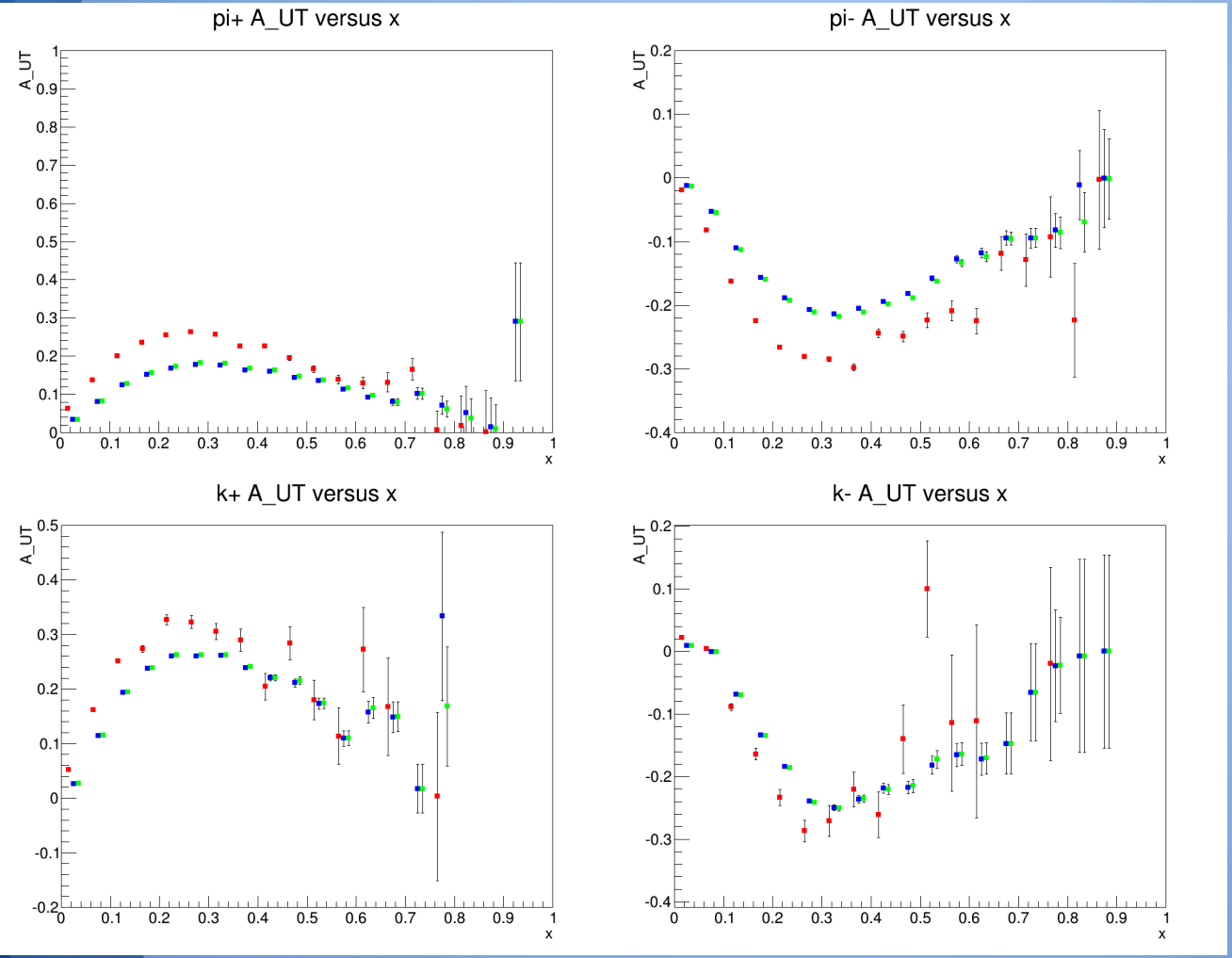
Semi-Inclusive DIS Simulation with pythia

- Put tof at 3.5 meters
- Proton energy 150 GeV, electron energy 5 GeV
- Integrated luminosity: 13 fb^{-1}
- With 10ps resolution, assuming particles could be identified with 3 sigma separation
- expression used to calculate transversity (http://arxiv.org/pdf/1303.3822.pdf Anselmino et al.)

$$A_{UT}^{\sin(\phi_h+\phi_S)} = \frac{\sum_q e_q^2 \int d\phi_h\, d\phi_S\, d^2\boldsymbol{k}_\perp\, \Delta_T q(x,k_\perp)\, \frac{d(\Delta\hat{\sigma})}{dy}\, \Delta^N D_{h/q^\uparrow}(z,p_\perp) \sin(\phi_S+\varphi+\phi_q^h) \sin(\phi_h+\phi_S)}{\sum_q e_q^2 \int d\phi_h\, d\phi_S\, d^2\boldsymbol{k}_\perp\, f_{q/p}(x,k_\perp)\, \frac{d\hat{\sigma}}{dy}\, D_{h/q}(z,p_\perp)},$$

- integrated transversity distribution from Anselmino
- integrated parton distribution from CTEQ5L

Results for Collins Asymmetries



- Red points : Using RICH only for pid
- Blue points: Using TOF only for pid
- Green points: using both

Acceptance: 5° to 30° (eta from 1.32 to 3.13)

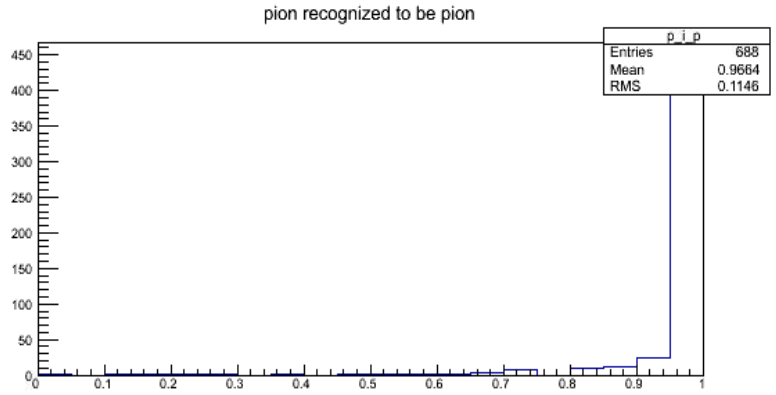
strange quark transversity distribution used average of up and down quark functions

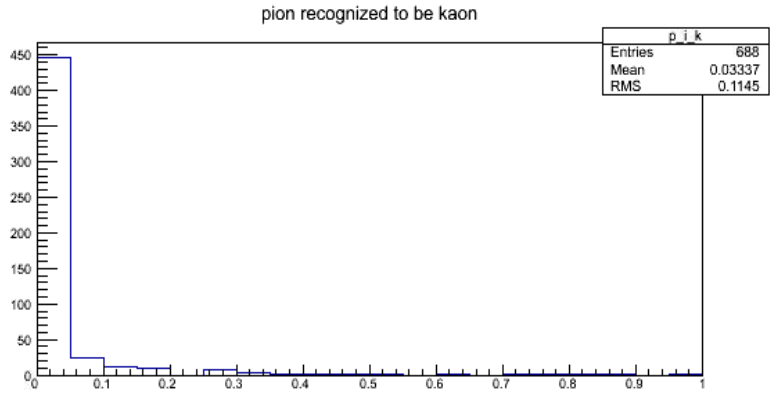
GEANT ANALYSIS

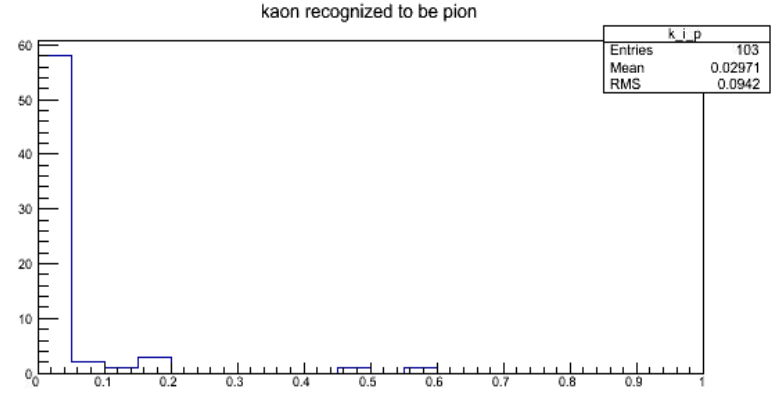
- Integrate tof into GEANT to get a more realistic simulation

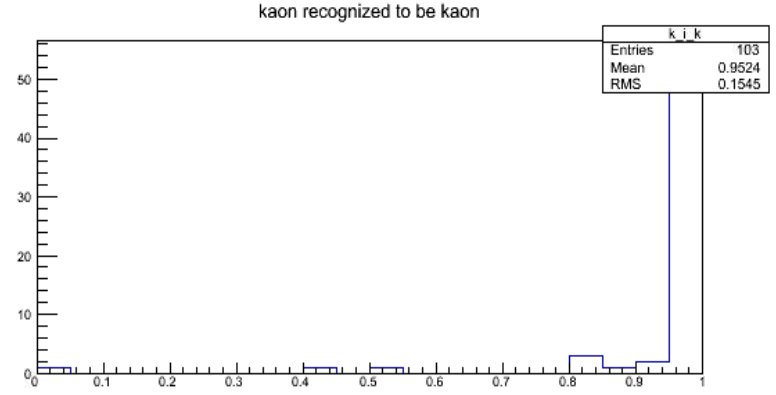
  Using GEANT simulation from Jin and similar detector layout in arXiv:1402.1209(ePHENIX)
- Forward TOF is put at 3.1 meters
- Proton energy 150 GeV, electron energy 5 GeV
- Likelihood analysis:
  - Calculate probability distribution function for each particle
  - Smear hits from GEANT with detector errors
  - compare these value with pdf to do pid

GEANT PARTIAL RESULT







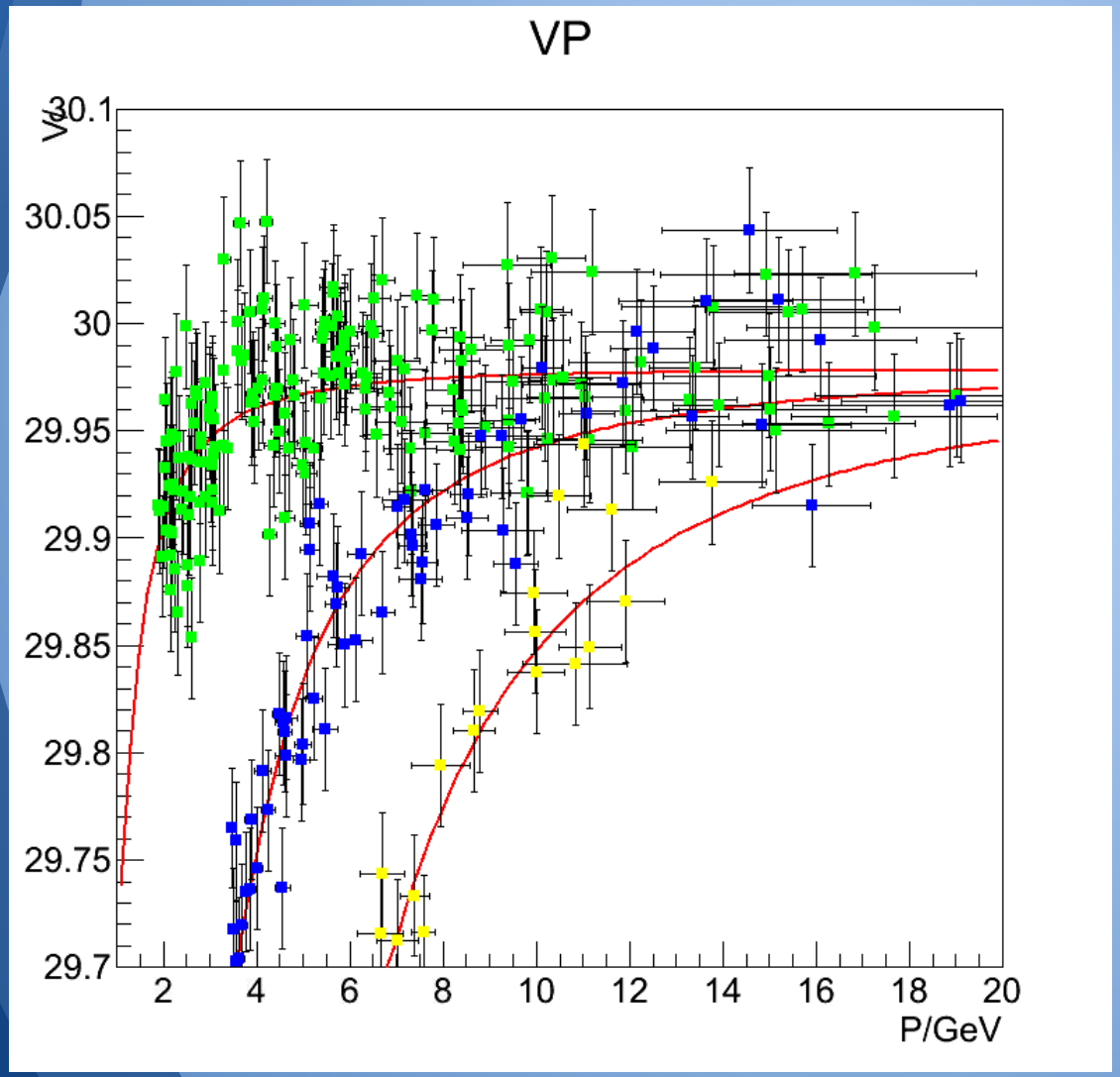


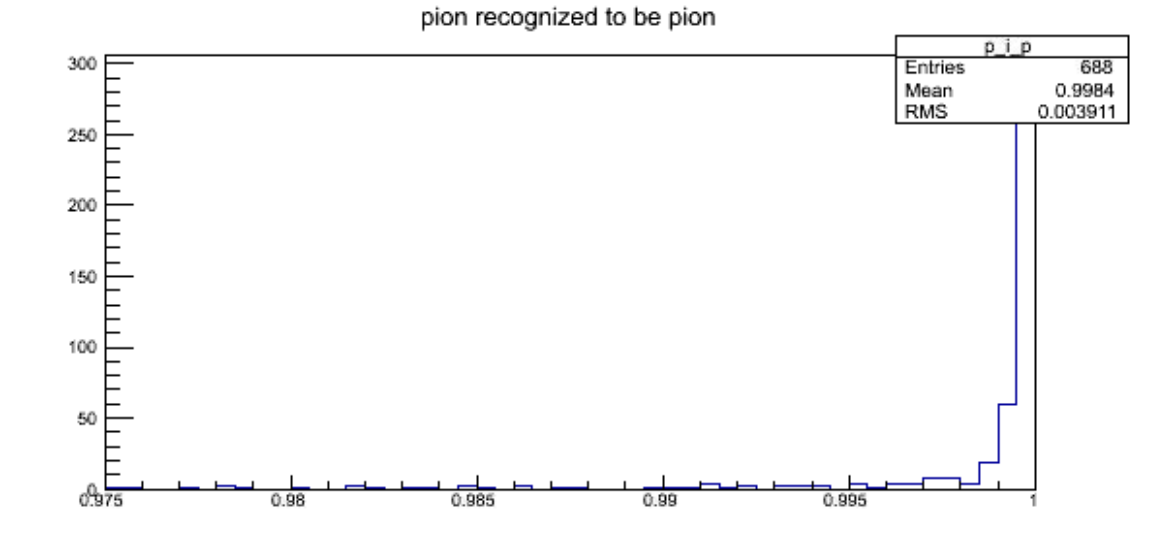
cuts: 2 GeV<p<8 GeV eta>1

FUTURE PLAN

We are planning to get hardware results on timing resolution and A_UT result from GEANT simulation before EIC R/D BOARD in july

Additional Slides


VP
Vp
30.1
30.05
30
29.95
29.9
29.85
29.8
29.75
29.7
2
4
6
8
10
12
14
16
18
20
P/GeV


pion recognized to be pion
p_i_p
Entries 688
Mean 0.9984
RMS 0.003911
300
250
200
150
100
50
0
0.975
0.98
0.985
0.99
0.995
1